UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF GEORGIA

RESOLUTE FOREST PRODUCTS, INC., *et al.*,	)	
	)	
Plaintiffs,	)	CIVIL ACTION FILE
	)	NO. CV116-071
v.	)	
	)	
GREENPEACE INTERNATIONAL, *et al.*,	)	
	)	
Defendants.	)	
	)	

DECLARATION OF DANIEL KNEESHAW
IN SUPPORT OF GREENPEACE DEFENDANTS'
MOTION TO STRIKE PURSUANT TO O.C.G.A. § 9-11-11.1

I, **DANIEL KNEESHAW**, hereby certify as follows:

I have been retained by Defendants Greenpeace International and Greenpeace, Inc. ("Greenpeace") to render expert opinions regarding the effect of alterations to boreal forests caused by logging on the woodland caribou. I submit this Declaration in support of Defendants' Motion to Strike Pursuant to O.C.G.A. § 9-11-11.1, and in response to the declaration submitted by Peter Reich on behalf of Resolute Forest Products, Inc., Resolute FP US, Inc., Resolute FP Augusta, LLC, Fibrek General Partnership, Fibrek U.S., Inc., Fibrek International Inc., and Resolute FP Canada, Inc. (collectively, "Resolute"). I am over the age of 21, and I am competent to provide this Declaration. I make this declaration based on my own personal knowledge, and for all purposes allowed by law.

Summary of Opinions

1. Large-scale forest operations alter forest conditions. Indeed, alteration of forest conditions is an explicit goal of traditional forest operations so as to increase timber production. There is strong scientific evidence showing ample reasons for environmental organizations such

as Greenpeace to be concerned about the effect of such alterations to the boreal forest in Quebec and Ontario, and in particular to wildlife species such as the woodland caribou.

2. In this declaration I will explain the multiple ways in which forestry practices modify forest ecosystems and have negative consequences on woodland caribou. I will focus on boreal forests in Quebec and to a lesser extent in Ontario. Specifically, I will show how current forestry practices create conditions that are different from natural conditions. I will then use government statistics to demonstrate the degree to which this alteration has occurred, and also show that the government itself is suggesting that practices be changed to consider the forest as habitat for organisms and to consider multiple uses (Jette et al. 2013).

Qualifications

3. Since 2001, I have held the position of Professor in the Biology department at the Université du Québec à Montréal. I have served as Chair of the doctoral program in environmental science for five of those years and as Chair of the Masters Program in Sustainable forest management for five years. My teaching and research interests are in forest ecology, silviculture, forest management, and climate change. I am affiliated with the Centre for Forest Research, a university-based research centre that draws together scientific expertise in forestry from across the province of Quebec.

4. Before being recruited to the university, I worked for two years as a research scientist for the Quebec government's Forest Research Directorate a branch of the Ministry of Natural resources (le Ministère des Ressources Naturelles) now the Ministry of Forests, Wildlife and Parks (Ministère des forêts, faune et parcs).

5. Among numerous recognitions from the forest science community, I was named as the first chief Editor of the Canadian Journal of Forest Research (2009-2013) from a French speaking university in the history of the journal. I also sat on the board of directors of Canadian Science publishing for two years 2011-2013.

6. I was an active member of the Sustainable Forest Management Network and I have served on various federal and provincial government panels on the topics of forestry and conservation. These included being the Quebec representative on Forest Productivity to the Canadian Council of Forest Minsters, being a member of the Forest Biodiversity Panel in Quebec, and the Panel for the Development of Quebec's Parks Network. I have also been called on to share my expertise in many regional public consultations, including being the scientific expert on biodiversity for the Concertation Table in the Mauricie region of central Quebec. I was also a scientific expert for Resolute Forest Products in the Mauricie for this division's successful forest CSA and then FSC certifications. I have consulted and evaluated other forest companies in Ontario and Quebec especially with respect to the FSC Standard on Forests of High Value for Conservation.

7. I have lead many research projects involving the industry (Resolute Forest Products, Tembec, Kruger etc.), government agencies (the Ministry of Forests, Wildlife and Parks and the Canadian Forest Service), First Nations (Anicinabe of Kitcisakik, Innu, Eeyou) and ENGOs. I've been the lead investigator on Pan-Canadian projects on sustainable forest management that integrated up to seven Canadian universities. I also have collaborated and published with researchers from the USDA Forest Service and forest researchers in Finland, Sweden, Russia, France, Spain and Belgium.

8. My work focuses mainly on the functioning and natural disturbance dynamics of the boreal forest at multiple spatial and temporal scales. More specifically, I've contributed substantially to the study of insect outbreaks, windthrow and gap-dynamics and their interactions with fire and logging. I've co-edited a book on forest ecosystem management that was one of the cornerstones for the 2013 reform of the forest act in Québec. I am committed to transferring this knowledge to practitioners and decision-makers from all organisations, in order to lead to the implementation of more sustainable ecosystem management practices.

Logging causes significant alteration to the age-class structure of the forest

9. In order to increase timber yield, forestry companies traditionally manage forests to create even-aged stands, which fundamentally alters the age-class structure of the forest by drastically reducing the quantity of old-growth forests. This significant alteration of natural conditions is of major concern for conservation of species using this habitat, including woodland caribou.

10. As background, in Quebec, the land area that is designated "commercial forest" (i.e., assigned to production forestry) is 277,300 square kilometers. 42% of this area has been logged over a 40 year period, with the proportion varying from 25 to 70% depending on the region (BFEC 2015). Approximately 60% of all forests below the northern limit of commercial forestry in Quebec are under logging agreements with forest companies, meaning that they can be logged.[1]

[1] A minority of lands are not under forest management agreements; of these 22% are non-productive, 13% are excluded (protected areas, etc.) and the remainder is not under the jurisdiction of the provincial government (private lands, federal lands like military bases).

11. In the boreal forest, the standard forestry practice is even-aged forest management, usually conducted using some form of clear-cutting. In this practice, all trees in a stand are cut, so that the stand regenerates with trees of a single age cohort. In Quebec, even-aged management through clearcut logging accounts for over 92% of all forest management in the boreal forest (BFEC, 2015).

12. At a stand level, in a forest managed in this fashion, all trees are of an equivalent age. At a larger scale (i.e. across a forest management area of thousands of square kilometers) the forest age-class structure consists of stands of different ages. As an example, one can consider a 1000 square kilometer forest managed on a 100 year rotation. In this example, the forest could be divided into one hundred units, each 10 square kilometers in size. Each unit would be cut once in a hundred years such that Unit One would be one year old, Unit Two would be two years old, etc.. Therefore, Unit 100 would be the maximum age of 100 years, and would be clear-cut this year, returning it to zero and starting the process again.

13. The age of maximum productivity (and thus the forest rotation age) is determined by foresters using growth and yield tables. In a forest managed only for timber production, stands older than that age would be eliminated. Thus in the example of a 100 year rotation, no stands will be older than 100 years. The goal of foresters is thus to modify the forest landscape structure as much as allowed by current laws so that old, over-mature stands are dramatically reduced in abundance (cf fig. 1 in Cyr et al. 2009).

14. Altering the forest age-class structure is thus a consequence of traditional forestry based on sustainable timber yield. However, by altering the forest, this forestry paradigm eliminates old forest habitat types. Species adapted to the original forest habitat types will thus

be at risk. This has been recognised by leading researchers in the U.S., Canada and Fennoscandia (Courtois et al. 2007, Fries et al 1997, Tikkanen et al. 2006). The renowned American ecologist, Malcom Hunter Jr., noted that forest dwelling species are adapted to the natural disturbance regimes and associated conditions that have occurred in different forest systems for millennia. Altering these forest conditions could thus put at risk certain species (Thompson 1991, Vors et al. 2007). To understand how the forest has been changed, it can be compared with natural conditions. One of those naturally-occurring conditions is fire.

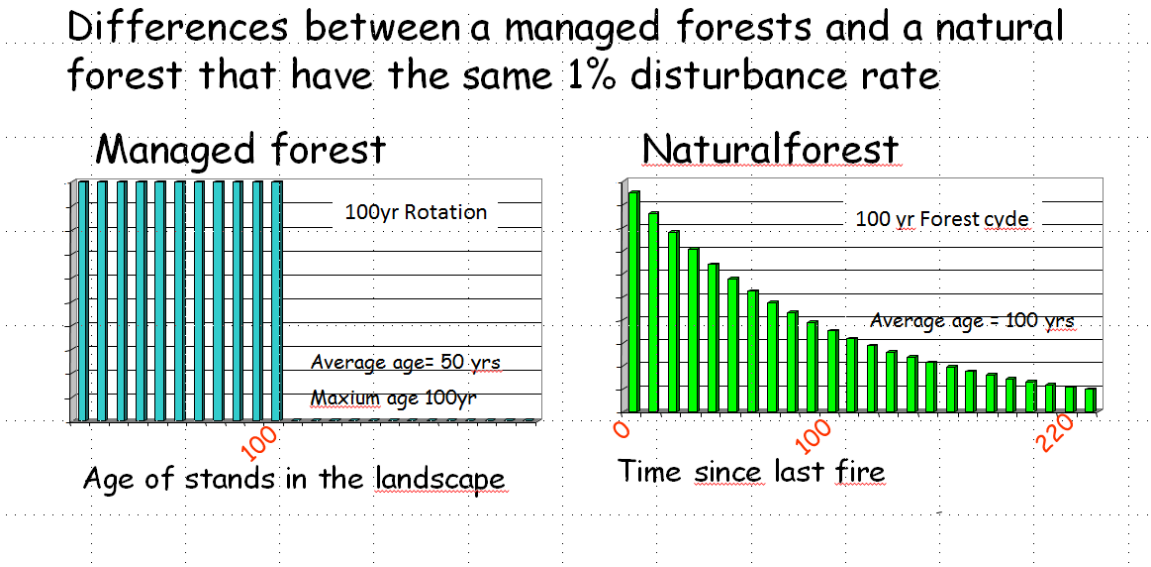
15. Fire is a dominant disturbance throughout the boreal forest. We can thus compare the age-class structure after logging with that found after a naturally occurring fire. Specifically, we can also look at the proportion and quantity of young forest to old forest. This can be calculated from forest burn rates (or fire cycles), which approximate the average age of the forest. The burn rate or the disturbance rate is the annual proportion of the forest area disturbed.

16. In the diagram below, I illustrate the difference between the age-class structure of a forest managed on a 100 year rotation (equivalent to a 1% disturbance rate) and a natural forest under a 100 year fire cycle (again, a 1% disturbance rate). In the managed forest all stands are harvested systematically whereas in the natural forest stands are affected 'randomly' so that some will attain great ages and others burn much younger.

17. In a study of ten regions from across Quebec, the historical natural burn rate over the last 300 to 500 years varies from 0.356 to 0.781 (Bergeron et al. 2006). The Quebec government suggests that forest fires burn even less frequently when averaged across the province and affect only 0.2% of Quebec's forests annually (Nappi 2013). The highest frequency of fires is found in the drier western part of Quebec and the lo 'est occurrence of fires is found in

eastern Quebec. A pan-Canadian evaluation showed similar burn rates across Ontario (Lauzon et al. 2006). In the areas with the slowest burn rates, the average time since fire will be 280 years, with many forests older than this. In the area with the highest burn rate, the average age of the forest will be 128 years (again with many forests older).

18. In contrast, a forest that is harvested on a 100-year cycle will have an annual disturbance rate of 1.0% but no stands will exceed 100 years (unlike with fires) (see Figure 1).



19. Thus the average age of a forest on a 100-year rotation will be 50 years. In Quebec's publicly owned boreal forests, forest are harvested on rotations that mostly vary from 70 to 110 years, i.e., disturbance rates vary from 0.9% to 1.4% (MRNFQ 2003b). Thus once foresters have achieved their goal, the average forest age will be 35 years to 55 years old and the maximum ages will be 70 to 110 years. This contrasts with disturbance from naturally occurring fires, for which the average forest age would be 70 to 100 years and the maximum ages would be over 200 years.

20. No forests in Quebec are managed at a rate of 0.5%, the disturbance rate mentioned by Dr. Reich. In Quebec, the harvest rate is almost two to three times higher. As discussed in Cyr et al. (2009), equivalent disturbance rates (logging vs. fire) do not yield the same results, since harvesting targets mature and old stands, dramatically reducing their abundance, while fire affects all age-classes, thus allowing some stands to reach much older ages.

21. Thus, managed boreal forests have a much lower mean and maximum stand age than natural forests even in the parts of the province with the highest burn rates. This alone constitutes a significant alteration to the age-class structure of these forests.

22. This is, however, only part of the story. Clearcutting does not exactly replace the function of forest fires. Forest fires continue to burn. Logging has thus an additive effect on top of fires. In other word, harvesting combines with fires to increase disturbance rates far above what natural ecosystems have undergone in historical times. In fact, it can even increase the risk of regeneration failure in burned areas; this can occur if the pre-fire stands were harvested recently and were too young to produce seeds (Girard et al. 2008).

23. In sum, the lowest harvesting rates (longest forest rotation) in Quebec's and most of Ontario's boreal forests are greater than the highest (shortest) natural disturbance rates. Boreal forest management is thus altering the natural forest age class structure. The quantity of old-growth forest is being drastically reduced, which is of concern for conservation of species using this habitat. This concern was recently noted by the Quebec government in a report on the importance of reducing the impact of forestry on the age class structure (Nappi 2013). Statistics from the Quebec government confirm this massive alteration: The Quebec government has

admitted that the volume of mature and over mature forest (i.e. old-growth forest) decreased by 8% from 1970-1979 to 1996-2011 (BFEC 2015).

Changes to forest composition

24. Forests in their natural states, before logging, have unique compositions of tree species that can be significantly altered by logging, leading to managed forests that have very different compositions than the original forests.

25. Many researchers have noted composition changes that began after large-scale forest operations. For example, Carleton and MacLellan (1994) report a conversion from conifer dominance to shade-intolerant hardwoods like poplar following logging in Northeastern Quebec, and Blais (1983) notes an increase in the less commercially desirable balsam fir, which is also more vulnerable to spruce budworm, a destructive insect pest. In Ontario, Jackson et al. (2000) also document a reduction in more valuable tree species and a large increase in shade-intolerant hardwoods . They attribute the increase in poplar in boreal Ontario to clear-cut logging. Even if stands are planted with conifers, faster-growing shade-intolerant species like aspen will dominate unless forestry treatments such as herbicides are used. Unless forest rotations are increased in length to 150 to 200 years intolerant hardwoods will increase in abundance across large regions since natural succession processes won't have time to restore conifer dominance.

26. The Quebec government recognizes that large-scale forest logging has modified forest composition across the commercial boreal forest. Government statistics show that coniferous forest cover (primarily spruce) has decreased by 21% since the 1970s in forest stands taller than 7 meters in height and that this is due mostly to an increase in shade-intolerant hardwoods like trembling aspen and paper birch (BFEC 2015).

27. This shift in forest composition leads to a shift in animal habitat and thus the species of wildlife present. Small mammal communities have shifted to communities dominated by early successional generalists (i.e. shade-intolerant species associated with open environments) following clearcut logging. In a later section the negative impact of clear-cut logging on woodland caribou will be explained.

Forest Structure

28. By reducing the age class structure, forest management also tends to homogenize forest structure. Old-growth stands are characterized by a complex structure that includes trees across a gradient of sizes. Forestry homogenizes this structure so that there is much less variation in tree size (Gauthier et al. 2008).

29. Height structure is also changing. An analysis of data from the Ministry of Forests, Wildlife and Parks forest inventory shows that between 1985 and 2005 there was a large alteration in the height structure of forests in the black spruce boreal zone. These data show that the quantity of forest greater than 7 meters in height decreased by 15,800 square kilometers and that this forest was replaced by 6,800 square kilometers of forests 4 to 7 meters in height and the rest in forest less than 4 meters in height. For organisms that use large trees (such as woodpeckers and cavity users like wood ducks, marten, etc.), this change to a smaller forest will greatly reduce available habitat (Andersson and Ostlund 2004, Nilsson et al. 2001).

Spatial structure

30. Spatially, there has been a loss of large blocks of mature forest. Fires burn big areas but bigger areas are saved between fires. The stochastic (random) nature of fires creates a mosaic where young patches of various sizes are randomly distributed within an older landscape

matrix. This isn't the case with forestry. Logging, historically, has occurred in a very different pattern which has had notable ecological consequences. Logging started in the south, near industrial infrastructures, and progressed northward. The resulting pattern is often described as the "unrolling of a giant carpet", where logging operations gradually move northward to the remaining mature stands. Mechanized clear-cut forestry in Quebec and in Ontario is thus occurring almost exclusively in primary forest (Gauthier 2008).

31. Forest harvesting currently removes tree stems from a site (leaving branches and roots), as the wood biomass is the product that is used by the industry. Natural disturbances, by contrast, create an abundant supply of dead wood. In Fennoscandia, where even-aged forest management has been practiced in their boreal forests for the last century, there has been a large reduction in dead wood. This has led to an increase in boreal species being added to the IUCN Red List of endangered species (Patry 2014, Tikkanen et al. 2006). As shown by Patry, the negative effect of forest harvesting operations on biodiversity in boreal Fennoscandia is a warning sign for Canadian boreal forests.

Road network

32. Roads are quasi-permanent alterations to the forested landscape. They have no natural analogue in nature. The Quebec government recognises that the forest road network is so extensive that between 4 and 5% of the productive forest has been transformed to roads (BFEC 2015). The negative effects of road networks on wildlife will be discussed in the section below on woodland caribou.

Carbon

33. Big trees capture and store more carbon than small trees (Stephenson et al. 2014). A study, in forests around the world, showed that having large trees permitted a forest to capture, as well as store, more carbon than in younger forests with smaller trees (Stephenson et al. 2014). As an example, a tree that is 9 centimeters in diameter and that grows 1 centimeter in diameter increases its cross sectional size by 59.7 square centimeters. By comparison, a 19 centimeters diameter tree that also grew by 1 centimeter in diameter would increase its cross sectional surface area by 122.5 square centimeters. If we assumed that both trees were the same height, the incremental difference in volume would be approximately 89,500 cubic centimeters versus 193,500 cubic centimeters

34. In the preceding example, if the trees are of the same species, and thus the wood is of the same density, then significantly more carbon would be accumulated in the larger tree even if growing with the same diameter increment. When we consider that forestry has reduced tree size and standing wood volume in Quebec (according to government data), then even if young trees sequester carbon more rapidly they are not able to make-up for the loss in allometric carbon gaining capacity. Bigger trees gain more mass at a faster rate than younger trees.

35. Finally, Reich states in his declaration that if all harvested trees in a particular forest tract were immediately burned, returning carbon to the atmosphere), this would “speed up climate change”, but that if logs were turned into fine furniture this would “slow climate change”. In other words, for forest products to be effective storage agents they must remain outside of the carbon cycle, and Reich is correct that wooden furniture would probably fit this description, but such furniture has a very small product base for Canadian Boreal forest products.

On the other hand, newsprint is consumed quickly and thus releases the stored carbon into the atmosphere. Notably, Resolute is the world's largest producer of newsprint.

Conclusion on forestry effects on forest dynamics

36. It is clear that forestry in boreal Quebec has altered habitat. Old-growth forests are targeted by foresters. Empirical evidence supports this reduction of old forest and increase in young forest. Reich suggests that a harvesting rate of 0.5% is similar to natural disturbance rates, but this number does not come from Quebec forests. In Quebec, harvest rates are approximately two times higher (0.9 to 1.4%) (MRNFQ 2003b). The other problem with Reich's argument is a harvest rate of 0.5% is equivalent to a 200 year rotation which means that foresters would not let any stands age past 200 years and that the average age would be 100 yrs. A natural disturbance rate of 0.5% would mean that the average age was 200 years (not the maximum), since fires may burn some stands at 50 or 75 years old which would allow other stands to age. In a natural system approximately one-third of the stands would be older than the rotation age. This alteration, although not recognized by Reich has been recognized by the Quebec government (Nappi 2013) The shift in age class structure is also associated with a composition shift from coniferous to hardwood composition. Is there a need to be concerned about these alterations to the boreal forests? I believe that there is. The reduction of old coniferous forest habitat by large-scale mechanized forestry reduces habitat for specialist species requiring these forest conditions. The early successional habitat abundant after clearcut logging is thus tipping the balance to generalist species such as poplars and moose that take advantage of high light, disturbed habitats. Beyond the literature cited and my own opinions, the Quebec ministry responsible for forest management also expresses concern about the effects of forestry. The Chief Forester's Office states that alterations to age class structure of more than 60 to 70%

will put at risk old-growth dependent species (Nappi 2013). Furthermore, according to the Quebec government, the number of vulnerable and threatened species in the managed public forest has increased from 8 to 15 wildlife species and from 34 to 51 plant species between 2008 and 2013 (BFEC 2015).

37. Caribou represent the best-known wildlife consequence, and there is significant empirical evidence of alteration to forest habitat having caused the extirpation of caribou from many areas and putting it a risk in many more.

Woodland Caribou

38. Concern for the long-term maintenance and survival of woodland caribou in areas with active large-scale forestry occupations is supported by scientific literature, government documents, federal and provincial laws and committees assigned to maintaining and increasing populations. The boreal population of the woodland caribou has been recognised as threatened under the Canadian Species at Risk Act and as vulnerable under Quebec's Law on vulnerable and threatened species (Festa-Bianchet et al., 2011). Once a species is recognized under either of these two laws special recovery plans become legal obligations.

39. The Chief Forester's office in Quebec (the office that determines the Annual Allowable Cut in Quebec) stated in 2015 that half of the area targeted by the recovery plan for woodland caribou had disturbance rates higher than the thresholds established by the scientific committee assigned to maintain and increase woodland caribou in Quebec and in Canada. The report clearly states that if current forest management practices do not change, then the maintenance of herds in these areas will be unlikely (BFEC 2015). Suggestions to the contrary are either disingenuous, uninformed or intentionally manipulative.

Historical range and extirpation due to human land-use

40. In eastern North America, the southern limit of the forest-dwelling caribou , an ecotype of woodland caribou (*Rangifer tarandus caribou*), has regressed following the expansion of human activities northward. Populations inhabiting managed forests are declining (Courtois et al., 2003). 150 years ago, Woodland caribou inhabited boreal forests as far south as the northern United States (New England), Maritimes and the southern shore of the St. Lawrence River.

41. Since the middle of the 19th century, the disappearance of woodland caribou has been documented and associated with human expansion. Woodland caribou disappeared from Vermont in 1840, from Wisconsin in 1850, from the Saint-Laurence valley in Québec in the mid-19th century, from Prince Edward Island in 1873, from New Hampshire in 1881, from Maine in 1910, from continental Nova Scotia in 1912, from Cape Breton in 1925, from Michigan in 1931 and from Minnesota in 1942. As of today woodland caribou has been extirpated from approximately half of its original range due to human activity (Badiou et al. 2011). Woodland caribou habitat has been greatly reduced and this species has been pushed north to less hospitable habitats. Similar situations have been observed throughout the entire Canadian boreal forest (Edmonds, 1991; McLoughlin et al., 2003; Schaefer, 2003), and many studies have linked recent reductions in numbers of this species to forestry activities (Rettie & Messier, 1998; Courtois et al., 2004; Wittmer et al., 2007).

42. In Ontario, between 1880 and 1990, caribou was progressively pushed northward at a rate of 34 kilometers per decade (Badiou et al. 2011). Vors et al (2007) showed that woodland caribou disappeared from a landscape less than twenty years after forest harvesting occurred. Their results suggest that a buffer zone of 13 kilometers should be preserved around cuts to reduce impacts on woodland caribou.

Conservation biology

43. In terms of conservation biology, this species is at risk because its slow population growth makes it vulnerable to habitat disturbance. The reproductive rate of the species is low with a maximum of one calf produced by breeding pair in a year. Mortality due to predation is particularly high in disturbed areas (i.e., due to logging) and is the biggest threat to species maintenance and recovery. (Festa-Bianchet et al. 2011).

44. There are a number of mechanisms by which forestry activities threaten woodland caribou due to reduced habitat, increased predation and reduced reproductive success. These will be developed in the following sections.

Reduction of good quality habitat and increase of sub-optimal habitat

45. Forestry reduces the amount of preferred caribou habitat. Caribou are then forced to use sub-optimal habitat. This can lead to use of a larger area to access alternative suitable foraging habitats (Chubbs et al. 1993; Smith et al. 2000), or to restriction to a smaller area to decrease movements in order to limit the risk of encounters with predators (Beauchesne et al. 2014). If caribou are forced to expand their ranges to find suitable foraging areas then they are at greater risk of predation. When this predation pressure increases then they are forced to reduce movements but are then restricted to suboptimal foraging.

46. Recent government of Quebec data documents how forest alteration is a danger to the long-term viability of woodland caribou. The most productive forest habitat for the woodland caribou is recognized to be in the commercial forest zone (*see* Paragraph 5 above and Jobidon et al. 2015 for a description of the commercial forest), although habitat occurs north of the commercial limit (MFFP 2015). Furthermore, as woodland caribou are pushed north they

hybridise with migrating tundra caribou. The MFFP report shows that north of the Grande reservoir the presence of woodland caribou is very unlikely (Figure 2).

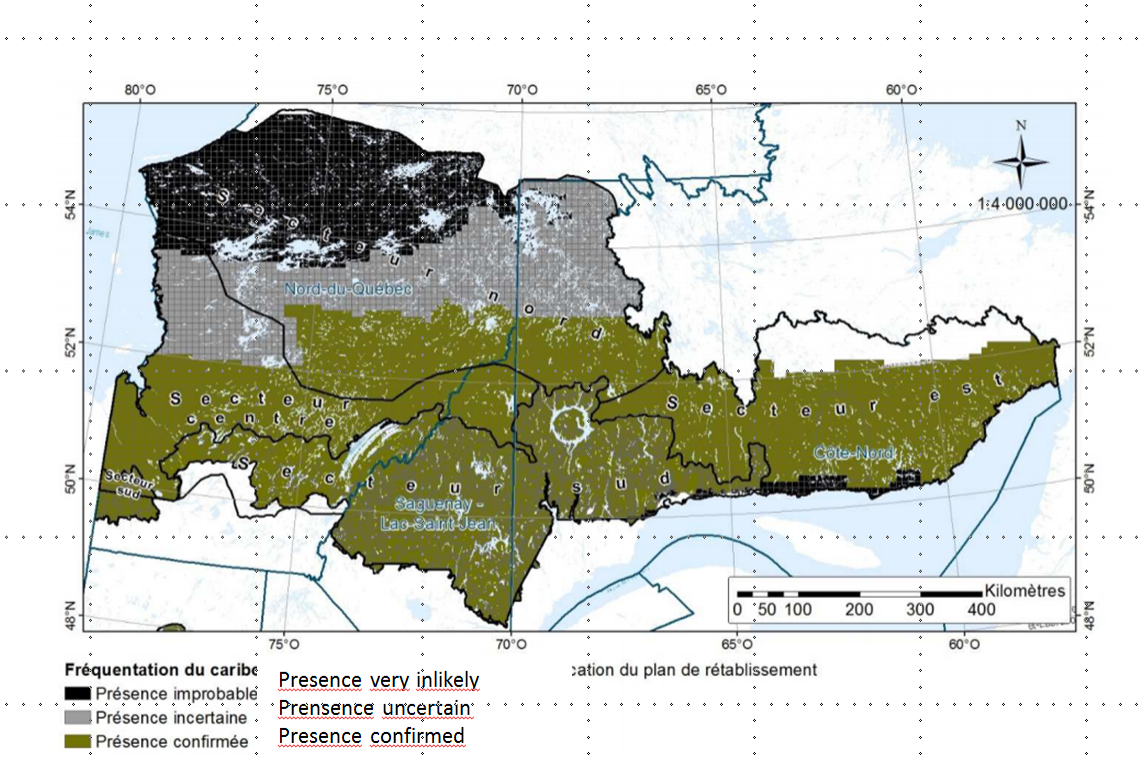


Figure 2. Areas frequented by woodland caribou in Quebec according to data from the Woodland caribou recovery plan for Quebec. The original figure is Figure 13 in MFFP 2015

47. A large proportion of woodland caribou north of the commercial forest limit is in less productive, inferior habitat that can only maintain smaller herd sizes. As a clear example, although the Chief Forester's office reports that only 25% of the area currently used by woodland caribou is south of the commercial forest limit, more than half of the woodland caribou population in Quebec is found in the commercial forest area (BFEC, 2015). In other words, three times the land area north of the commercial limit is required to support less than half the population. This information, found in government reports published in French, was not included in Reich's evaluation.

48. Without the habitat in the commercial forest, the woodland caribou in Quebec would be reduced by more than half. Given that this species is already at risk, focusing only on forest land north of the commercial limit, as suggested by Reich, is not a viable option to maintaining woodland caribou. In a reduced zone with less than half of current numbers, both demographic variability and environmental variability (hard winters, etc.) could lead to extirpation of the species.

49. The woodland caribou recovery plan for the Quebec population clearly states that although northern forests are an integral part of the plan, there is a necessity to maintain herds in the commercial forest zone to maintain the long-term viability of the species in Quebec. According to Quebec law and the federal species at risk act, maintaining current numbers is not enough. There is a legal requirement to maintain and increase the populations of this species (Loi sur les espèces menaces et vulnerable http://legisquebec.gouv.qc.ca/fr/ShowDoc/cs/E-12.01 and the Canadian Species at Risk Act http://laws-lois.justice.gc.ca/eng/acts/s-15.3/ If a wildlife species is listed as an extirpated species, an endangered species or a threatened species, the competent minister must prepare a strategy for its recovery). This will require active conservation in the more hospitable range that coincides with current forest operations in forests south of the commercial forest limit. The recovery plan working group of woodland caribou experts stated, in a report accepted and published by the Quebec government, that if current forest management strategies are unchanged, the maintenance of woodland caribou population in the area covered by the recovery plan would be unlikely (MFFP, 2015).

50. The BFEC 2015 report clearly states that the biological needs of the woodland caribou may come into conflict with the socio-economic concerns of some communities. The Chief Forester's Office in 2015 subsequently calculated the effect of withdrawal of some

territories, including 'les Montagnes blanches' land area, from the harvestable forest. It determined that the maximum effect on annual allowable cut (AAC) (the amount of wood that a company can cut per year in an area) for the forest industry would be between 4 and 15%. The Chief Forester's Office further stated that since the forest industry was currently (2001 through to 2012) only harvesting 80% of the Annual Allowable Cut in these areas, the real effect would be closer to the lower bound (4%) (BFEC 2015).

Loss of old-growth coniferous forest and increase of forage for competing species

51. Among the direct impacts of harvesting on boreal woodland caribou at a local scale (stand scale i.e. 10 to 100 hectares) is the increased rate at which old coniferous stands, its preferred habitat, are converted to young stands (Courtois et al. 2007). Old-growth coniferous forests are better for caribou than younger forests. Their denser cover aids in predator avoidance during calving and post-calving (Rettie & Messier, 2000). Peatlands, jack pine stands, and conifer dominated lichen woodlands are documented as essential conifer cover types during the calving period and in winter (Schaefer & Pruitt, 1991; Rettie & Messier, 2000). In contrast to Reich's suggestion that woodland caribou use clearcuts, researchers have also demonstrated that harvested areas are avoided by woodland caribou (Chubbs et al., 1993; Courtois et al., 2007; Schaefer & Mahoney, 2007).

52. The conversion of older forest to early successional stands leads to an increase in early successional vegetative species (see earlier section on forest alteration), providing abundant forage for other ungulates such as moose (Courtois et al., 2004; Wittmer et al., 2007). An increase in moose density leads to an increase in wolf (*Canis lupus*) density, thus increasing predation pressure on woodland caribou, a known alternative prey for wolf (Seip, 1992). Early successional stands also offer the highest biomass of berries, providing suitable foraging habitat

for black bears (*Ursus americanus*) (Brodeur et al., 2008), a major predator of caribou calves (Lambert et al., 2006). Both a change in tree species composition and increased predation of woodland caribou have been observed by scientists and by the government following forestry operations.

Road networks

53. The development of a dense road network to enable access for logging companies is another consequence of harvesting, and these roads are avoided by the boreal caribou. Roads have no natural analog and the well developed tertiary road network provides an easy access for wolves to quickly explore a territory (Baidou et al. 2011). It has also been observed that primary and secondary managed roads for forestry favour the accumulation of other activities (cottages, hunting, recreation, etc.) which disturbs the area and increases avoidance by woodland caribou (Badiou et al. 2011) The network of permanent forest roads tripled in the 30 year period from 1975-76 to 2001-02 (MRNFQ, 2003a). In Quebec, until the last few years there has been no mechanism to deactivate roads and there is still no revegetation of roads to reduce their use by predators. The concept of roadless areas that is prevalent in some parts of the U.S. (such as in national forests) has not yet been embraced in Québec.

Habitat disturbance and size requirements

54. According to scientific experts on the Environment Canada recovery panel, for woodland caribou populations to be maintained or increased, the proportion of disturbance in a landscape should not exceed 40% (Environnement Canada 2008). In Quebec, the 2013-2023 recovery plan for woodland caribou -- a plan required by law -- recommended maintaining disturbances (natural and human caused) to less than 35% in order to ensure that there would be a greater than 60% chance of caribou populations being self-sustaining. Currently only 30% of

the area analyzed for the recovery plan would be likely to maintain self-sustaining populations. The authors also note that self- maintenance of populations is unlikely in 45% of the area currently inhabited by woodland caribou.

55. The size of forest undisturbed by logging or fires is a key factor in the viability of woodland caribou populations (Courbin et al. (2009)). A recent study showed that the viability of woodland caribou varied from 40 to 48% in undisturbed forests that were 100 square kilometers in size, to approximately 53 to 62% for undisturbed habitat 250 square kilometers in size. A mature undisturbed coniferous forest greater than 500 square kilometers in size was required to reach a viability of 75% (Lesmerises, 2011). Maximum viability was observed for mature undisturbed habitat greater than 1,000 square kilometers in size. The caribou recovery plan calls for areas of up to 5,000 square kilometers to be conserved (MDEFP, 2013). Such large undisturbed arears are increasingly rare in the commercial forests of Quebec. They are of high priority for conservation of this species.

Conclusion

56. Mounting evidence suggests that forest management (at least as currently practiced) and the maintenance of self-sustaining woodland populations are not compatible. The self-maintenance of woodland caribou is not considered to be probable when disturbance exceeds 35 to 40% of an area. Large undisturbed areas are also required, i.e., more than 500 square kilometers but preferably 1000 square kilometers to 5000 square kilometers . Such areas are exceedingly rare due to large-scale forest management. Woodland caribou's preferred habitat is old conifer dominated forests. Old-growth forests have been greatly reduced in Quebec. Mature conifer forests have also been reduced and replaced by hardwoods. Young hardwood stands provide forage for moose which attracts wolves which are a key predator of

caribou along with black bears. Road networks that are built to provide access for logging, which have no natural analogue and permanently alter forests, are also rapidly increasing and facilitate the movement of these predators. The commercial forest south of the northern limit provides critical habitat for the woodland caribou. Although only one-quarter of the land area currently used as habitat is south of the commercial limit, this productive habitat is home to more than half of the woodland caribou population. Any suggestion that forest south of the commercial forest limit is not critical for the maintenance and recovery of woodland caribou clearly ignores the well documented situation in Quebec. Although these documents are in French, the woodland caribou recovery team, the chief forester's office and the Ministry of Forests, Wildlife and Parks have all clearly stated that current forest practices in this zone put the long-term maintenance and recovery of woodland caribou at risk. There is thus ample reason for environmental groups to express concern over the impact of current logging practices by forestry companies on woodland caribou.

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